portion to their height, and tapering to sharper summits, which however are obtuse and bifid. The breadth of the tooth slightly increases to the posterior pair of eminences, whilst in the *Mastodon longirostris* and *angustidens* the crown maintains the same breadth, or more commonly becomes narrower from the anterior to the posterior pair of mastoid eminences.

Other differences observable on a minute comparison are too trivial to deserve notice, especially when observed in only a single example of a complex molar tooth. In the Australian specimen under consideration the mastodontal characters are unmistakeable, and the resemblance to the molar teeth of the *Mastodon angustidens* is very close. The specific distinction of the Australian Mastodon rests, at present, only on the slight differences pointed out in the form of the mastoid eminences and the contour of the crown of the molar tooth.

The question may arise, whether identity of generic characters in the molar teeth of an extinct Australian mammal with those of the *Mastodon* can support the inference that the remaining organization of the Proboscidian Pachyderm coexisted with such a form of tooth? The analogy of the close mutual similarity which exists in the molar teeth of the Tapir, Dinothere, Manatee and Kangaroo suggests the surmise that the mastodontal type of molar teeth might also have been repeated in a gigantic Marsupial genus which has now become extinct; and such an idea naturally arose in my mind after having received evidence of the marsupial character of the *Diprotodon* and *Nototherium* *, two extinct Australian genera, with the tapiroid type of molars, represented by species as large as a Rhinoceros.

The more complex character of the molars of the *Mastodon*, and the restriction of that character, so far as is now known, to that genus only, makes it much more probable, however, that the molar here described belonged to a true *Mastodon*, and the species may be provisionally termed *Mastodon australis*.

London, August 22, 1844.

XXXV.—*An Attempt to Classify the* Tetrabranchiate Cephalopods. By William King, Curator of the Museum of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.

The following observations on the Tetrabranchiate Cephalopods are in substance the same as some which formed part of two lectures which I delivered in the autumn of 1841 in the Theatre of the Literary and Philosophical Society of Newcastle-upon-Tyne.

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* The characters of these genera and the evidences of their marsupial nature will be the subject of a future communication.

It will be seen that these shells are classified not only according to their agreement with each other in general character, but also in accordance with their relative order of creation. The synopsis at the end will make this mode of classification intelligible at one view.

In a paper which I read at a meeting of the Natural History Society of Northumberland, &c. in March 1843, on the family *Unionidæ,* the following view was advanced:—"I would again urge attention to the two elements which are necessary to be attended to in classifying any section of the animal kingdom, namely, *agreement of structural character* and *relative order of creation.* If all animated forms had been produced at the same time, and there had been no previous dying out of these forms, the plan that is generally adopted in arranging a zoological group, that is, by attending to structural resemblances alone, would be perfectly admissible; but as innumerable species (for the most part extinct) have succeeded each other during former periods of the world's history, it follows, that to introduce such species in a natural classification, without any reference to their order of creation, would be equivalent to constructing a genealogical chart without attending to the relative period of the different families." Entertaining this view, it may be readily conceived that I read with considerable interest the Chevalier Agassiz's observations, which have recently appeared, on the classification of Fishes, and especially the following remark:—"It will not be sufficient henceforwards to group genera and species according to their organic affinities; we must also take into account the relative age of their appearance on the surface of the globe, and the importance of each group in the different epochs of the general development; in a word, zoology ought to comprehend in its systems the genealogy of the whole animal kingdom*."

The Cephalopods have been divided into two sections, depending on their having two or four gills; those with two gills are termed Dibranchians, and such as have four are called Tetrabranchians. This is Prof. Owen's arrangement and nomenclature. The Calamary, Cuttle-fish, Argonaut, and Spirula are examples of the dibranchiate, and the Pearly Nautilus represents the tetrabranchiate section.

The Dibranchians are extremely common at present; as yet, we have no evidence that they lived during any portion of the primary period; but from the abundance of their remains in the corresponding rocks, it is certain that the secondary seas sustained them in incredible numbers. The Tetrabranchians appear to have existed at an early period of organic time; and the occurring of their testaceous coverings in every subsequent deposit, together with their still inhabiting the Southern Ocean, prove that they have survived to the present day.

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* Vide a translation of this paper in the last number (73) of the 'New Edinburgh Philosophical Journal.'

If we examine a specimen of the Pearly Nautilus which has been longitudinally divided, its inner part will be seen to consist of a number of cells or chambers, the partitions or dividing plates of which have a small tubular perforation in the centre. The animal or mollusk which inhabits this shell is, allowing for some important differences, allied to that which tenants an ordinary univalve: it occupies the outermost chamber; but a portion of its enveloping tegument or mantle, in the shape of a slender membranous tube or siphon, accompanied with a vein and an artery, passes through the whole of the chambers by means of the tubular perforations*. This tube may be one means of keeping the animal fixed in its place; but the principal seem to be two muscles, one on each side of the body, which are connected with the lateral walls of the chamber.

It is generally supposed that the chambers constitute "an apparatus which renders the Nautilus nearly of the same specific gravity as the surrounding water, and enables it to rise to the surface of the sea, or sink to the bottom, simply by altering the extent of the surface exposed to the water by its soft parts†."

Now the Ammonite or snake-stone, as it is popularly called, is a shell which is constructed on the same general plan as the Pearly Nautilus, and which it is generally admitted was fabricated by a cephalopodous mollusk‡. Specimens of the Ammonite are quite common which show distinctly their inner part divided in the same manner as the Nautilus, but in each of these genera the siphonal sheath is differently placed, and the plates have a different form. In the Ammonite the siphonal sheath is in contact with the outer or dorsal part of the shell, whereas it is central or nearly so in the Nautilus: and the edge of the plates, instead of being plain and slightly sinuous, as in the last genus, alternately curves before and behind a line corresponding to the plane of the centre of the plates, so that allowing this line to pass through a series of curves, the edge may be said to be divided into an anterior and a posterior set of lobes, which are either simple or compound, according to species; further, these lobes, throughout their whole contour, are set off with numerous pointed digitations, which are invariably directed backwards, that is, towards the origin of the whorls. These digitations, Dr. Buckland observes, may have served as holdfasts, by which the posterior part of the animal's mantle could fix itself firmly, and as it were take root around the bottom of the outer chamber.

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* The siphon appears to have been strongly protected in some fossil Nautiluses both by an elongation of the tubular perforation and by additional calcareous tubes (*N. sipho* and *N. striatus*, Buckland in 'Bridgewater Treatise'). These parts, whether only one or both are known to occur in a fossil, will be considered in the light of a *siphonal sheath*, and as such will be termed in the following pages.

† In my lecture, as it was originally delivered, Dr. Buckland's hypothesis respecting the use of the siphon was examined. This hypothesis having been shown to be untenable by the researches of Prof. Owen (vide Hunterian Lectures on the Invertebrate Animals), I have thought it necessary to cancel my original remarks, and to replace them by the above extract from Dr. Mantell's highly interesting 'Medals of Creation.'

‡ The Ammonites, and all the other shells mentioned in this paper, are placed in the tetrabranchiate division of the Cephalopods, in accordance with the views of Prof. Owen.

The remains of both these divisions of the Tetrabranchians are common to certain of the secondary rocks. In the Silurian portion of the primary period a great many of the then existing cephalopodous shells possessed plain-edge plates, and thus they agreed so far with the Nautilus; but strictly speaking, their siphonal sheath cannot be said to be central, since it is often situated within and at a distance more or less from either the outer or the inner margin of the plates.

These early cephalopodous shells arrest our attention by the variety of shapes which they have assumed. They may be said to run into every conceivable form from a close coil to a straight line. The straight ones have received the name of *Orthocerus*; those which are curved are called *Cyrthocerus*; and such as are tendril-shaped or open-coiled have been termed *Gyrocerus*: these last appear to be closely allied to some whose coils are in contact with each other, and for which may be used the provisional name *Discus* *: again, these conduct us to a shell which is close-coiled when young, but afterwards it strikes off at a tangent: this is Montfort's genus *Lituites*. Besides these, several other kinds have been described and otherwise named.

It has been observed, that in a great many of the Silurian Cephalopods the siphonal sheath oscillated as it were between the outer and the inner edge of the plates without touching either. Along with these there existed others somewhat different, inasmuch as the edge of their plates is more or less sinuous, and their siphonal sheath is placed in some on the outer, and in others on the inner margin of the plates: these constitute the genera *Goniatites* and *Clymenia*.

Now it is a remarkable fact, that in whichever genus of the tetrabranchiate Cephalopods we find the edge of the plates undulated, we in general observe the siphonal sheath approximating to the dorsal or to the ventral aspect of the shell. Hence we have no difficulty in graduating the Discus with its simple plates and oscillating siphonal sheath, either into the Goniatite or the Clymenia.

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* Sowerby, in the 'Mineral Conchology,' has applied Montfort's name *Ellipsolithes* to these shells (compare generically *E. funatus*, tab. 32, with *Nautilus undosus* of the 'Silurian System'), which cannot be allowed, since Montfort's genus was founded on a species of *Ammonites* from the Chalk near Rouen.

From the close-coiled *Discus* to the straight *Orthocerus*, our passage is with as little difficulty effected through the genera *Gyrocerus* and *Cyrthocerus*.

Thus the Silurian period has furnished us with various cephalopodous forms, which, notwithstanding their dissimilarity, may be linked together in perfect harmony. We shall now endeavour to connect them with some of the same class which have since sustained their part throughout the various organic revolutions of our globe.

In passing from the Silurian to the Carboniferous period, most of the forms which have been mentioned accompany us; they deviate however more and more from their original types as we leave in the distance our starting-point: thus most of the Carboniferous Goniatites differ from the simple-lobed species of the Silurian rocks in having the edge of their plates more complicated; and several of the Carboniferous Nautiluses are distinguishable from their Silurian prototypes, the Discuses, by their possessing the true conventional characters of the genus in which they have been placed.

The Cephalopods with a ventral siphon, as the beautiful Clymenias, do not appear to have undergone any amount of change; nor do they seem to have long survived the epoch of their creation. It is otherwise, however, with those which were furnished with a dorsal siphon: they made their first appearance during the Silurian epoch; thence we are able to trace them through the whole series of stratified deposits to the Cretaceous* æra,—thus continuing throughout two immense geological periods, the primary and secondary. During this range, the edge of their plates underwent a variety of modifications: in the first instance, the plates had simple lobes, such as are displayed in the Silurian Goniatites; the crown of the dorsal and lateral posterior lobes, however, became divided or digitated in the Carboniferous species†; afterwards, for example, in the Triassic period, the divisions became decidedly more numerous, and even the sides of the posterior lobes which verge on the dorsal aspect of the shell assumed this character, as may be observed in the Ceratite[*]; and subsequently, that is, throughout the Jurassic and Cretaceous epochs, the whole contour of the posterior, and also of the anterior lobes, became digitated, which is shown in the beautiful foliations of the Ammonite.

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* The palæontologist, who is of opinion that we are *now acquainted with the fossils of every geological period*, may be disposed to question this assertion, and to dwell upon the absence of these shells in the Permian rocks.

† The simple dorsal lobe of the early *Goniatites* is divided in most of the Carboniferous species, according to Vicomte d'Archiac and M. de Verneuil: the posterior lateral lobes which verge on the dorsal aspect of the shell are divided in *G. mixolobus*, *G. cyclobus* and *G. Looneyi*; and in a species (———) from the western side of the Oural Mountains, specimens of which are in the Russian collection of the Newcastle Museum, the crown of all the lateral lobes is divided.

It has been previously remarked that the plain-edge-plate Cephalopods or Nautilidians[†] of the primary period ran into a variety of shapes, from a close coil to a straight line,—a disposition which we never find displayed in the early Ammonidians[‡], as the Goniatites, nor in their successors, the Ceratites: but no sooner do the Ammonites appear than they imitate the forms of their remote predecessors: thus a certain section of the last disunites its coils and becomes the gyroceroid Criocerus[§]; this before long completely unfolds itself, and thus we have the cyrthoceroid Ammonocerus[||], whose light and graceful arch is afterwards unbent to form the fragile orthoceroid Baculite. But our list of changes still remains unexhausted: another section of the Ammonites retains the normal form for a certain time; then strikes off its coil at a tangent to be afterwards curved back, and hence we have the Scaphite; and the Criocerus, as if conscious that it could improve this figure, assumes the more pleasing yet singular form of the Ancylocerus.

But these forms are merely modifications of the shell unfolding its coils on one and the same plane. Unlike the primary shells in this respect, certain of the Ammonidians are obliquely coiled or spiral, and the coils strike off from the slight deviation exhibited in the Jurassic *Turrilites Boblayei* to the extreme which is observable in the Cretaceous *T. costatus*.

The Turrilite is essentially an Ammonite having a spiral convolution, inasmuch as the coils, in both kinds, are in contact; but the last is not the only form that passes into a spirally coiled Cephalopod, since we find the evolute Criocerus *obliquating* its coils to become the Heliocerus.

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[*] In none of the figures that I have seen of the Ceratite is the character particularized in the text represented: it is displayed in a specimen belonging to the Newcastle Museum.

[†] Family *Nautilidæ*.

[‡] Family *Ammonidæ*.

[§] According to Mr. Morris (Catalogue of British Fossils) a species of *Criocerus* is found in the Kelloways rock, Wiltshire.

[||] Lamarck's genus *Ammonocerus* is evidently the same as D'Orbigny's *Toxocerus*, which is of a later date. D'Orbigny states that it is found in the Jurassic system, but does not mention in which division. I found it in the Jurakalk near Streitberg, Franconia, in 1839. *Criocerus* must be found in an earlier, or at least an equivalent rock, before what is said in the text of *Ammonocerus* can be received, even as a sound metaphor.

The development of so many genera of the foliate-plate cephalopodous shells at a time when they were about to disappear, would almost induce the notion that every form that could be assumed had been tried to perpetuate them: but a grand organic change was to arrest their evolutions: that change was to annihilate them:—and thus the eve of the secondary epoch, which had seen them luxuriating under every form, was destined to be a witness to the final struggles of the Ammonidians!

Let us now turn our attention to the Nautilidians. It will be recollected that we left them revelling in the Carboniferous epoch under the forms of *Orthocerus, Cyrthocerus, Discus* and *Nautilus.* With one exception, and at the close of this period, these forms became suddenly extinct, and even the excepted genus—the last, appears to have with difficulty escaped the fate of its congeners, since the deposits which were formed during the succeeding ages, the Permian and the Triassic, yield us but few species. Afterwards the Nautilus seems to have completely recovered from the check which it had previously sustained, as the Jurassic and the Cretaceous rocks teem with new specific forms. This state however did not continue, for the same devastating influences which overtook the Ammonidians encompassed the Nautiluses: the first were destroyed and the last survived; but only to live in reduced numbers during the Tertiary epoch, and to be reduced still more in our own.

Like the Ammonidians of the Jurassic and the Cretaceous period, some of the contemporaneous Nautiluses appear under characters somewhat different from those of their predecessors: for example, the slightly sinuous edge which in general marks the plates of this genus is lobed in such species as *Nautilus sinuatus* and *N. biangulatus*; the same character appears to have been preserved in *Nautilus Danicus,* and it would seem to have arrived at its maximum in the Tertiary *Nautilus sipho* and *N. ziczac.*

We have now traced the Tetrabranchiate Cephalopods throughout their entire existence. We have observed them in one period abounding to excess, and in the next to become considerably reduced; then again to burst forth in countless numbers, and afterwards to become all but extinct.

Shall we conclude that the existence of but two species in the present seas indicates an approximating termination to their career? A knowledge of their past history ought to make us pause before we adopt this conclusion, for what have we to oppose their re-entering another Jurassic period?—their again appearing in a thousand forms?—in short, what have we to disprove, that they are still destined to sustain an important part in the future zoological revolutions of our globe?

The principal genera of the Tetrabranchiate Cephalopods classified according to their agreement in general character and chronological appearance.

Primary Period.				Secondary Period.			Tertiary Period.	Quaternary Period.
Silurian Epoch.	Devonian Epoch.	Carboniferous Epoch.	Permian Epoch.	Triassic Epoch.	Jurassic Epoch.	Cretaceous Epoch.		
Orthocerus.	Orthocerus.	Orthocerus.	Orthocerus?	Orthocerus?	Orthocerus?			
Cyrthocerus.	Cyrthocerus.	Cyrthocerus.						
Gyrocerus.	Gyrocerus. Clymenia.	Clymenia?						
Discus.	Discus.	Discus.						
Lituites.								
		Nautilus.	Nautilus.	Nautilus.	Nautilus.	Nautilus.	Nautilus.	Nautilus.
					Lobed Nautilus.	Lobed Nautilus.	Lobed Nautilus.	
Simple Goniatites.	Simple Goniatites.	Simple Goniatites.						
		Digitated Goniatites.	Digitated Goniatites?	Digitated Goniatites?	Digitated Goniatites?			
					Ancylocerus.	Ancylocerus. Baculites.		
					Ammonocerus	Ammonocerus.		
					Criocerus.	Criocerus.		
				Ceratites.	Ceratites?			
					Ammonites.	Ammonites.		
					Turrilites.	Scaphites. Turrilites.		
					Heliocerus.	Heliocerus.		

Notes connected with the Synoptical Table.

I have drawn up the foregoing Table without having seen that which accompanies Agassiz's paper: the translation in Professor Jamieson's Journal is all that I have seen at present.

It must be understood, that I offer this classification of the Tetrabranchiate Cephalopods only as an approximate one. It is for the principles of such a classification that I contend. The genera *Orthocerus, Ceratites* and *Goniatites* have been carried up into the Jurassic epoch, because they have been found in the St. Cassian (Tyrol) beds, associated with Ammonites and other fossils of this age.

If the Ceratites are of the epoch mentioned in the last note, and the Ammonites did not exist previously, it follows that the latter must be connected with the former, as represented in the Table.

I confess that I have little faith respecting the Ammonites having died out at the close of the secondary period. In the case of many species and genera we find, that although they have ceased to exist in our own seas, they are still to be found living in other latitudes: this fact leads me to think, that the Ammonites may have lived within the tropics during the deposition of the early tertiary beds of France and England. In making this remark, I have in view the Ammonidians of Pondicherry and other places in India.

The generic difference between the Russian *Goniatites* —— ? and *Ceratites nodosus* is so trifling, as to cause me to think that the last genus will yet be found as low down as the Permian or the Carboniferous series. Fossils undoubtedly form a good character by which to enable the geologist to decide as to the age of a rock; but it ought always to be borne in mind, that unless the relative position of such a rock to others whose general character is known can be fairly made out, the organic test should be received with due caution.

I have placed the Scaphites in connexion with the Cretaceous Ammonites; it is probable however that they existed previously to the latter. There is a Jurassic species of *Ammonites* (I do not know the specific name at present) which becomes contracted and irregular as it advances in age; perhaps it stands in the same relation to the true Scaphites as the Jurassic *Turrilites Valdani* does to the true Turrilites of the Chalk.

The Table will show that I differ from D'Archiac and De Verneuil as regards *Nautilus sipho* and *N. ziczac* being Clymenias (Trans. Geol. Soc. vol. vi. p. 328); and from Buckland and others respecting these lobed species forming the link between the Ammonites and the Nautiluses. The way in which I have spoken of the Discuses in the lecture would imply that I consider them to form the original type of the Tetrabranchiate Cephalopods: it seems preferable to wait until we know more of the early fauna of our planet before any positive opinion is hazarded on this point.